Modifications to Bypass System Operations to Improve Hydraulics

Investigator

Connie DeMoyer Svoboda
Hydraulic Engineer
Hydraulic Investigations and Laboratory Services
Bureau of Reclamation
Denver, CO 80225
csvoboda@usbr.gov

Summary

To achieve fish collection at the Tracy Fish Collection Facility (TFCF), the primary and secondary facilities must effectively guide fish into the bypass systems. Fish collection efficiency in the primary channel is strongly influenced by the bypass ratio (the ratio of the channel velocity to the bypass entrance velocity). Bates *et al.* (1960) and the California Department of Water Resources (1963) have shown the importance of sustaining bypass ratios greater than 1.0 to maintain effective fish collection. According to Table II of Decision 1485 Water Quality Standards for the Sacramento-San Joaquin and Suisun Marsh, bypass ratios must be above 1.0 and the secondary channel velocity must be held at 3.0–3.5 ft/s from February–May while salmon are present and less than 2.5 ft/s from June 1–August 31 for striped bass, shad, and catfish.

High pumping rates at the C.W. "Bill" Jones Pumping Plant and low water levels in the Sacramento-San Joaquin Delta produce high velocities in the TFCF primary channel according to flow continuity. Velocity control (VC) pumps need to be turned on in the secondary facility to produce primary bypass entrance velocities that are greater than the primary channel velocities to maintain a bypass ratio greater than 1.0. When many VC pumps are in operation, unacceptably high velocities in the secondary channel may result. To keep secondary channel velocities within fisheries criteria, primary bypass discharges must be limited. This, however, means that the resulting primary bypass ratios are often less than 1.0. When bypasses are operating with ratios of less than 1.0, a portion of the flow at the bypass entrance is turned back and reversed within the transition box. This flow passes back out of the bypass and through the louvers, likely generating high fish losses and reduced collection efficiencies.

According to the 2009 National Marine Fisheries Service (NMFS) Biological and Conference Opinion, "Reclamation shall operate the facility [Tracy Fish Collection Facility] to meet design criteria for louver bypasses and channel flows at least 75% efficiency" (NMFS 2009). By closing one or two of the primary bypasses, more water flows through the bypasses that are open. This produces higher primary bypass ratios in the open bypasses while limiting the overall flow to the secondary channel. Under this operational mode, the facility may achieve fisheries criteria for both velocity and bypass ratio under a broader range of environmental conditions.

Limited hydraulic data on closing bypasses was collected during the performance evaluations of the replacement bypass intakes in FY 2005 to guide the development of the operational modification concept. Data were collected 10–15 ft upstream of the

bypass intakes and at three lateral locations in the secondary channel upstream of the first louver line during various operations with closed bypasses. The approach bypass profiles did not look quantifiably different from approach profiles collected under four bypass operations and the secondary data did not appear to be skewed due to closed primary bypasses. Since adverse conditions were not detected by closing bypasses, a draft Facilities Operations Table was created. Like Mecum's Table that was developed in 1977 for striped bass salvage, this table aims to recommend the best operation of the facility at given primary water velocities and primary channel depths. If field testing shows that closing bypasses is a viable method for improving facility operations, bypass closures will be indicated on the table along with VC pump operation.

Problem Statement

Due to high pumping rates from the Jones Pumping Plant and reduced water levels in the Sacramento-San Joaquin Delta, primary bypass criteria and secondary velocity criteria cannot always be achieved at the same time at the TFCF. When VC pumps are turned on to produce bypass ratios greater than 1.0, secondary velocities may exceed criteria. The objective of this study is to determine if closing one or more primary bypasses can be used to increase facility compliance with stated criteria. When bypass valves are closed, more flow is pulled through the open bypasses, producing higher primary bypass ratios in the open bypasses while limiting the overall discharge entering the secondary channel. If closing bypasses produces favorable hydraulic conditions based on this field study, modifications to the draft Facilities Operation Table will be suggested and fisheries and debris testing will be recommended.

Goals and Hypotheses

Goals:

1. Determine whether closing bypasses will increase bypass ratios without producing unacceptable flow patterns near the primary bypass intakes or in the secondary channel.

2. Determine whether closing bypasses results in decreased water levels in the secondary channel.

3. Suggest modifications to the draft Facilities Operation Table based on hydraulic results, and recommend fisheries and debris evaluations to assess the impacts of closing bypasses on fish salvage and debris management.

Hypotheses:

1. Closing one or more primary bypasses will increase primary bypass ratios.

2. Decreased water levels will occur in the secondary channel, but the benefit of achieving primary bypass ratios above 1.0 will outweigh the slight increase in secondary channel velocities.

Materials and Methods

Field studies will be conducted in FY 2010 during five pump operation at the Jones Pumping Plant. During VAMP (one to two pump operation), the primary velocities are low enough to achieve adequate primary bypass ratios while maintaining velocities of 3.0–3.5 ft/s in the secondary channel during salmon criteria, so field evaluations are not necessary during this time. Field work will be scheduled during a period of low daytime tides, because low water levels produce difficult conditions for achieving criteria. Debris levels should be low to minimize the influence of debris in these initial hydraulic tests. High debris levels can complicate data analysis. Debris tests will be accomplished at a later time if the hydraulic results appear promising.

The Qmetrix Qliner velocity profiler will be used to collect data near the primary bypasses and in the secondary channel. The Qliner consists of an acoustic Doppler current profiler mounted to a boat. Single plane, narrow beams will provide accurate data close to the primary louvers and near the walls in the secondary channel. A handheld computer collects data via a Bluetooth transmitter.

Velocity profiles will be collected at three lateral locations in the secondary channel upstream of the first louver line during standard four bypass operations and under operations with one closed bypass and then two closed bypasses. Velocity data will be collected in the secondary channel for a few trial bypass closures to document whether closing bypasses will skew approach flow in the secondary channel. Skewed flow may affect the ability of fish to gain entrance to the fish bypass.

After the secondary channel is evaluated, velocity profiles will be collected in the primary channel under a range of water surface elevations and VC pump operations as one or more bypasses is closed. Velocity profiles will be collected approximately 10-ft upstream of the primary bypass during operation with all four bypasses and during bypass closures. Approach velocities should gradually accelerate into a near-uniform vertical velocity distribution at the bypass entrance. The approach velocity profiles collected at open bypasses will be compared to determine if bypass closures produce eddying, reverse flows, or skewed velocity profiles. At closed bypasses, the velocity profiles will give an indication of the flow field that fish would experience while approaching a closed bypass.

The following data will be collected during the hydraulic field investigation:

- System wide hydraulic data, including documentation of the primary, secondary, and holding tank flow rates, primary and secondary velocities, bypass ratios, VC pump operation, and water levels throughout the facility.
- Velocity profiles 10 ft upstream of non-operating bypass intakes and detailed observations and photographs of flow patterns around the bypasses.
- Velocity profiles 10 ft upstream of operating bypass intakes and detailed observations and photographs of flow patterns near the bypasses.
- Document bypass ratios and flow depths for which steady, well directed flow is sustained from the primary channel through the bypass entrance.
- Velocity profiles at three lateral locations across the secondary channel to document flow uniformity when bypasses are closed.

If closing bypasses appears to be beneficial hydraulically, modifications to the draft Facilities Operation Table will be suggested to include the closing of primary bypasses. At this point, questions about fish entrainment and debris accumulation in non-operating bypasses will need to be discussed with TFCF staff and appropriate external parties The primary intake guide walls may need to be removed or a physical barrier to the bypass entrance may be required to optimize fish guidance around non-operating bypasses. A fisheries study will likely be needed to verify that fish respond favorably to the new operational conditions. The use of injected fish will be better for controlled trials to determine the efficiency of the modified operational procedure. During the fisheries evaluation, hydraulic measurements will be collected to document hydraulic conditions. Debris testing will also need to be conducted to determine whether debris accumulation in closed bypasses is detrimental to fish salvage and/or facility operation.

Coordination and Collaboration

Coordination will be required between the Technical Service Center staff and the TFCF Biology and Operations staff. Connie DeMoyer will conduct the hydraulic evaluations with assistance from Brent Bridges. Connie and Brent will interpret results and determine whether closing bypasses should be recommended for addition in the Facility Operations Table. If fisheries and debris evaluations are needed, staffing and coordination will be determined at that time.

Endangered Species Concerns

There are no take considerations for the hydraulics portion of this study. Endangered species considerations will be required if a fisheries evaluation is performed.

Dissemination of Results (Deliverables and Outcomes)

Velocity data will be recorded in digital format. Findings will be presented in graphical format and will include analysis and interpretation. If closing bypasses yield favorable hydraulic conditions, the updated Facility Operations Table will be reviewed and verified by TFCF staff and operators. Results will be presented in a Tracy Series Report with the recommendation that fisheries and debris evaluations be conducted. If results show that operations should not be altered by closing bypasses, a test summary will be submitted as a technical memorandum.

Literature Cited

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